Narumi NAKATO*: A cytogeographical study of *Pteris dispar* Kunze

中藤成実*: アマクサシダの細胞地理学的研究

Pteris dispar is distributed in China, Taiwan, Japan and Korea (Nakaike, 1975), occurring in lowland areas in subtropical and warm temperate regions. Walker (1962) reported the chromosome number of this species as n=29 and 2n=58 for the Taiwanese plants and 2n=58 for the Japanese plants. Mitui (1967, 1976) also observed the chromosome number n=29 for the materials from Isl. Amami-oshima and Isl. Iriomote of the Ryukyu Islands. However, Kawakami (1979) reported the chromosome number 2n=116 for the plants from Hiroshima Prefecture. These results indicate that there are two cytotypes within this species, i.e. diploid and tetraploid based on x=29.

In this paper, the detailed geographical distributions of these cytotypes are reported.

Materials and methods Plants were collected at 30 localities shown in Table 1. Root tips were used for observations of chromosomes. After pre-treatment with 0.002M 8-hydroxyquinoline solution for 3 hours, the root tips were fixed in 45% acetic acid for 10 minutes. Then, they were hydrolyzed in 1N HCl at 60°C for 2 minutes and squashed on slides. Aceto-gentian violet or aceto-orcein was used for staining. Spores were mounted with Canada balsam and measured their equatorial diameters, except equatorial collars, with 50 samples per specimen. All voucher specimens are preserved in TNS.

Observations Chromosome numbers were examined in 112 individuals from Japan and Taiwan. Of these, 38 plants were diploid with 2n=58 (37 plants) or 2n=ca. 58 (1), and the remaining 74 were tetraploid with 2n=116 (63) or 2n=ca. 116 (11) (Table 1, Fig. 1 A & B). There was no case in which the two cytotypes were detected in the same locality. The localities of the plants examined are mapped in Fig. 2, which is prepared on the basis of the present and the previous reports mentioned above. As shown in Fig. 2, the diploid plants were found restrictedly in southern areas, i.e. Taiwan and the Ryukyu Islands, while the tetraploids were detected in northern areas, i.e. Kyushu, Shikoku,

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Tab. 1. Summary of chromosome counts of *Pteris dispar*.

Locality	Number of plants	ploidy	Voucher specimen (TNS no.)
Miaoli, Taiwan	3 (1)*	2×	395001～3
Isl. Okinawa-honto, Okinawa Pref.	3 (3)	2×	395004～6
Isl. Tokunoshima, Kagoshima Pref.	15 (15)	2×	395007～21
Isl. Amami-oshima, Kagoshima Pref.	17 (16)	2×	395022～38
Isl. Yakushima, Kagoshima Pref.	1 (0)	4×	395039
Isl. Tanegashima, Kagoshima Pref.	5 (2)	4×	395040～4
Ei, Kagoshima Pref.	1 (1)	4×	395045
Sakurajima, Kagoshima Pref.	1 (1)	4×	395046
Kagoshima, Kagoshima Pref.	10 (6)	4×	395047～56
Tano, Miyazaki Pref.	1 (1)	4×	395057
Yunotsuru, Kumamoto Pref.	1 (1)	4×	395058
Osakama, Kumamoto Pref.	1 (1)	4×	395059
Kokonose, Oita Pref.	2 (0)	4×	395060～1
Tahira, Nagasaki Pref.	1 (0)	4×	395062
Kunimi, Nagasaki Pref.	2 (0)	4×	395063～4
Tsukushino, Fukuoka Pref.	3 (1)	4×	395065～7
Ube, Yamaguchi Pref.	3 (0)	4×	395068～70
Kubotsu, Kochi Pref.	8 (5)	4×	395071～8
Yasu, Kochi Pref.	11 (2)	4×	395079～89
Kushimoto, Wakayama Pref.	1 (1)	4×	395090
Isl. Awajishima, Hyogo Pref.	1 (0)	4×	395091
Kyoshi, Osaka Pref.	1 (1)	4×	395092
Katano, Osaka Pref.	3 (3)	4×	395093～5
Honnagashino, Aichi Pref.	1 (1)	4×	395096
Ashikubo, Shizuoka Pref.	1 (1)	4×	395097
Kawazu, Shizuoka Pref.	5 (1)	4×	395098～102
Ajiro, Shizuoka Pref.	4 (4)	4×	395103～6
Isl. Kozushima, Tokyo Pref.	1 (0)	4×	395107
Isl. Miyakejima, Tokyo Pref.	1 (1)	4×	395108
Kiyosumiyama, Chiba Pref.	4 (3)	4×	395109～12

* Number of plants used for the measurements of spore size.

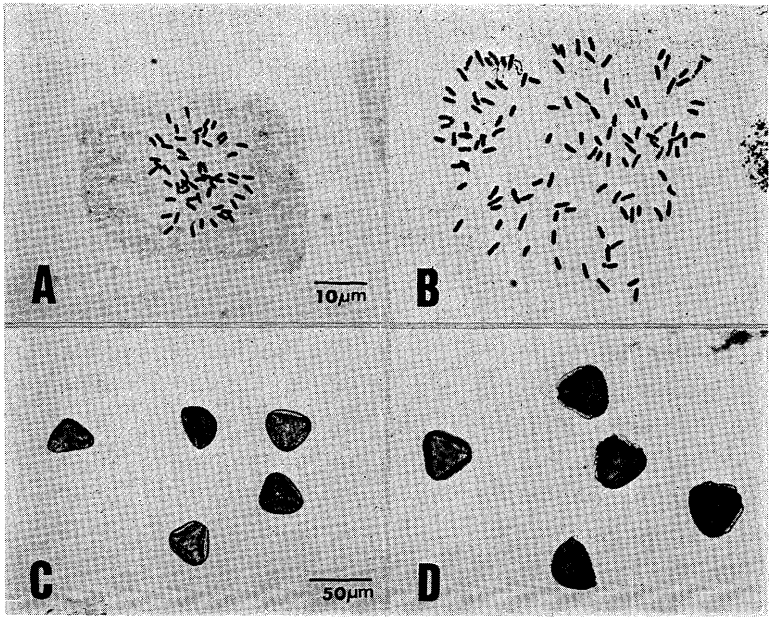

Fig. 1. Photomicrographs of somatic chromosomes (A & B) and spores (C & D) of *Pteris dispar*. A & C: diploid (2n=58) from Taiwan (TNS no. 395001); B & D: tetraploid (2n=116) from Kumamoto Pref. (TNS no. 395059).

Honshu and their neighboring islands.

There was no distinct difference between the diploids and the tetraploids in such external morphological characters as the frond shape, the number and shape of pinnae and segments, and the color and texture of lamina. Only the scale-length showed tendency to be longer in the diploids (usually 3-6 mm) than in the tetraploids (usually 1-4 mm). The spore sizes of 72 voucher specimens were examined to ascertain whether the ploidal difference was expressed in this micro-character (see Table 1). All of the 72 specimens had normal-shaped trilete spores (Fig. 1 C & D). The mean spore diameters of the diploids were mostly less than 33 μm, while those of the tetraploids were more than 33 μm, though there was a slight overlap (Table 2).

In connection with the above observations, the spores from 78 herbarium specimens preserved in TNS and KYO were also examined for their sizes. The results are schematically shown in Fig. 3. As seen in Fig. 3, the mean values of spore size were generally smaller in the specimens from Taiwan (28.2-31.0

Tab. 2. Number of voucher specimens of *Pteris dispar* showing respective mean diameter of spores.

	28—29—30—31—32—33—34—35—36—37—38—39 (μm)												mean of means
2×		3	10	6	12	2	2						30.6 μm
4×							4	10	8	10	4	1	35.6 μm

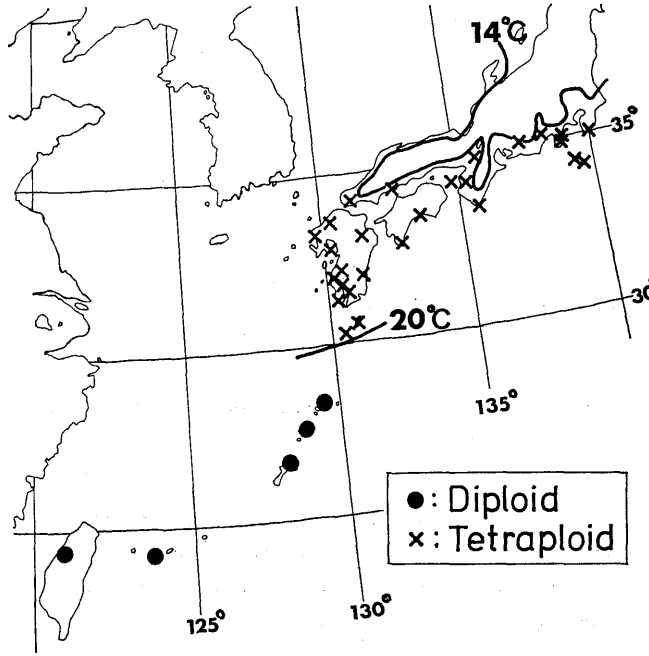

Fig. 2. Distribution of two cytotypes of *Pteris dispar*. Broad lines indicate the isothermal lines of mean tnnual temperatures.

μm) and the Ryukyu Islands (28.8-33.1 μm) as compared with those from Japan proper (33.3-37.4 μm) and Isl. Querpart of Korea (34.9-35.9 μm). Judging from the spore sizes in the voucher specimens (Table 2), the herbarium specimens from the former regions are considered to be diploid and those from the latter regions to be tetraploid. Two Chinese specimens from Kwangtung (Tsang nos. 20693 & 21244, KYO) had relatively larger spores, being 34.0 μm and 34.9 μm in mean diameter respectively, which were referable to those of the tetraploid

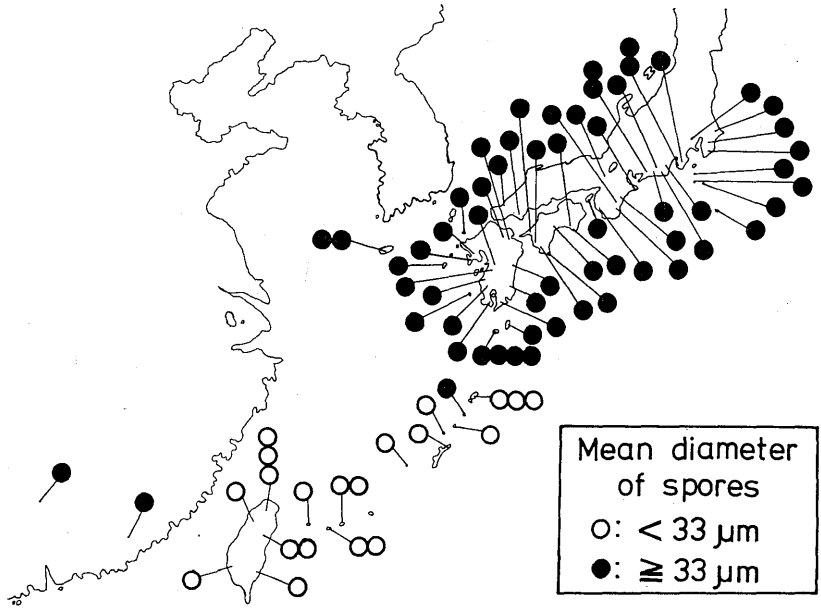

Fig. 3. Localities and spore-sizes of the herbarium specimens of *Pteris dispar* examined.

in Japan.

Discussion It is clear from the present study that the diploids of *P. dispar* are distributed in Taiwan and the Ryukyu Islands and the tetraploids in Japan proper north of Isl. Amamioshima. The border line of the ranges of the two cytotypes seems to be situated at the Tokara Strait lying on about 29-30°N between Isl. Amami-oshima and Isl. Yakushima. It is noted here that the Tokara Strait is known to form an important phytogeographical demarcation line in Japan (Koidzumi, 1932). The isothermal line of 20°C of mean annual temperature and that of warmth index value 180, which are usually regarded as the boundary values between subtropical and warm temperate zones, border on south of Isl. Yakushima (cf. Kira *et al.*, 1976). Furthermore, as shown in Fig. 2, the northern limit of distribution of this species agrees nearly with the isothermal line of 14°C of mean annual temperature. From these facts, the temperature is considered to be the most important factor determining the ranges of the two cytotypes in Japan and Taiwan, and the diploid and the tetraploid

seem to be adapted to subtropical and warm temperate climates, respectively.

The polyploidization in this species seems to be important advantage for its distributional expansion to north. This cytogeographical situation is in marked contrast to that of *P. excelsa* Gaud. in Japan, in which the ancestral cytotype, sexual diploid, is widely distributed even in the northern regions, while the derived cytotypes, apogamous diploid and triploid, occur mainly in southern warm regions (Nakato, 1976).

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アマクサシダには2倍体 (2n=58) と4倍体 (2n=116) が知られている。それらの地理分布を確かめるため，日本・台湾の30産地から112株を採集し，染色体数を算定した。台湾・琉球列島産の38株はすべて2倍体，屋久島以北の産地から得た74株はすべて4倍体であった。証拠標本について胞子の大きさを測定すると，各々の標本の平均値は，2倍体株が 28～34 μm，4倍体株が 33～39 μm であった。胞子の大きさにより2つのサイトタイプがある程度区別できることがわかったので，国立科学博物館と京都大学に収められている腊葉標本より胞子を採取し，それらの大きさを測定した。78標本について調べたところ，その結果は，各サイトタイプが先に述べたような異なった地域に分布することを裏づけるものであった。以上の観察から，台湾・日本においては，2倍体は亜熱帯域に，4倍体は暖温帯域に分布することが推察された。このことはアマクサシダにおいて倍数化が北方への分布の拡大に重要な役割を果していることを示している。